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Industrial Bottomfish Fishery of the Northern Gulf of Mexico, 1959-63

By

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Industrial Bottomfish Fishery of the Northern Gulf of Mexico, 1959-63[1]

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ABSTRACT

Distribution of fishing effort, composition of landings, harvesting operations, and processing methods are described for the industrial bottomfish fishery of the northern Gulf of Mexico. The more important fishing grounds are located between the Mississippi River Delta and the entrance to Mobile Bay. The Atlantic croaker contributed, on the average, 56 percent by weight to the total annual bottomfish landings during 1959-63.

Analysis of annual production, catch per unit of effort, and total fishing effort indicated that the bottomfish population maintained itself at reasonably productive levels over the 5-year period. Recommendations concerning complete utilization of the bottomfish resource of the area are suggested.

INTRODUCTION

Bottomfish averaging less than one-half pound each are commonly caught by commercial fishermen trawling for shrimp along the coast of the northern Gulf of Mexico. Prior to 1952, this resource was not utilized because no market existed for the small fish that were discarded at sea. In 1952, the petfood industry established a cannery at Pascagoula, Miss., to manufacture animal food products from the bottomfish resource of the Gulf. Initially, trawlers delivered fish caught incidentally with shrimp, but insufficient quantities of fresh fish supplied in this manner ultimately resulted in the plants employing vessels that sought bottomfish exclusively. Reduction plants also began processing fish for fish meal in Louisiana. They were furnished raw material by shrimp trawlers making catches during the off-season for shrimp, as well as by vessels retaining fish caught when shrimp were abundant. Other firms in Louisiana and Mississippi have developed processing and transportation facilities to supply Midwest mink-food markets with frozen bottomfish.

In 1958 the Gulf States Marine Fisheries Commission recommended that funds be made available to the Bureau of Commercial Fisheries to undertake a study of the industrial fishery of the northern Gulf of Mexico. Later that year the Bureau began a biological and statistical survey to assess the extent and value of the bottomfish fishery. The objectives of the continuing research program were to determine the following: (1) composition of the commercial landings, (2) areas, seasons, and amount of fishing effort, (3) population size, (4) vital statistics of the important species, and (5) relation between variations in population size and fishing effort.

This report describes the industrial bottomfish fishery, including types of vessels, gear, method of operation, species composition of catch, areas and seasons of fishing, and measurements of catch, effort, and bottomfish abundance.

[1] Contribution No. 202, Bureau of Commercial Fisheries Biological Laboratory, Galveston, Tex.

DESCRIPTION OF FACILITIES AND METHODS

FISHING VESSELS, GEAR, AND HARVESTING OPERATIONS

The industrial trawler fleet consists largely of vessels originally designed for the shrimp fishery. They are about 50 feet long and have an average fish capacity of 30 tons. They are propelled by diesel engines, most of which are rated at about 165 horsepower (hp.). They usually make trips lasting from 1 to 3 days and fish close to plants at Mississippi and Louisiana ports (figure 1). Running time to the grounds varies from 1 to 6 hours at an average speed of 9 knots. Ice is used to preserve the catch.

Also included in the fleet are several larger vessels which range from 60 to 94 feet in length, are powered by diesel engines rated at 185 to 578 hp., and have capacities varying from 63 to 125 tons. They generally make 4- to 6-day trips of up to 200 miles from Mississippi ports to the Louisiana grounds west of the Mississippi River Delta. Most of the larger vessels are equipped with ammonia and brine refrigeration units.

All vessels are operated by two to three men and are equipped with radio-telephones, echo sounders, and power-driven winches.

The resident bottomfish trawler fleet comprised an estimated 50 vessels during the 5-year study period. Transient vessels have been and continue to be used to catch bottomfish for petfood and fish meal plants during slack periods in the shrimp fishery. The pet-

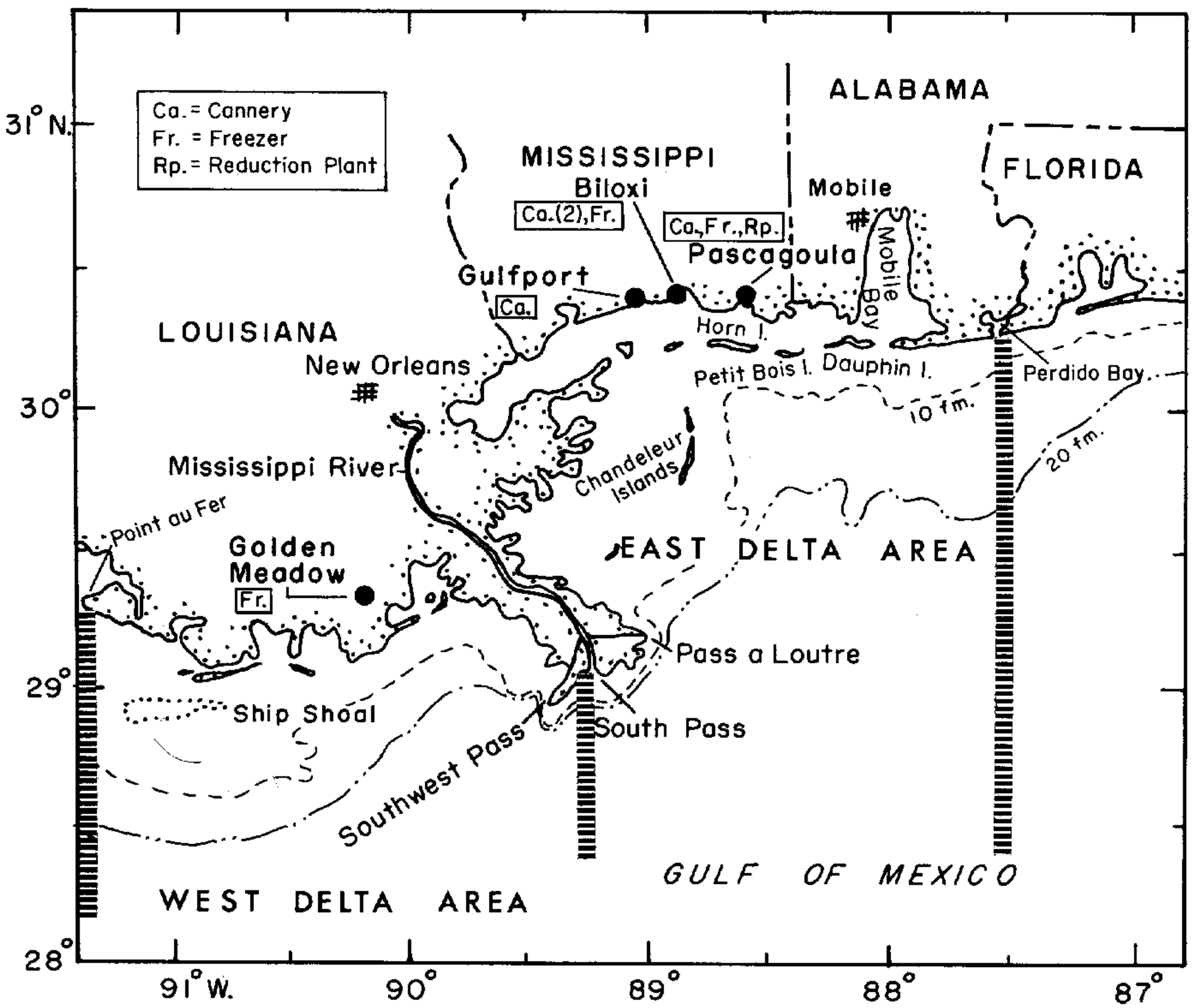

Figure 1.--Fishing grounds of the industrial bottomfish fishery in the north-central Gulf of Mexico. Heavy striped lines indicate limits of the West Delta and East Delta fishing areas.

food industry customarily places the fishing vessels on regulated trip schedules to provide a steady supply of fish when fish are abundant. (Thompson and Haskell, 1960). The schedules

are abandoned when fish are scarce. Each resident trawler averaged 3-1/2 trips a month during the study period.

Most vessels fishing for industrial bottomfishes pull a single otter trawl from a boom located amidship and projecting aft. A few trawlers tow two trawls, or a "double-rig," from the port and starboard booms which project laterally. Gulf of Mexico bottomfish trawls, commonly of the "balloon" type (in contrast to the "flat" design that is widely used for catching shrimp), are uniform in configuration but vary considerably in dimension. Net width along the lead line of trawls used by "single-rig" vessels varies from 60 to 110 feet, whereas "double-rig" vessels fish smaller nets ranging in width from 50 to 80 feet. The net is held open by two otter boards, or trawl doors, to each of which a net wing is directly attached. The doors are hung on a bridle that joins the vessel's towing warp. Mesh size varies from 1-1/4 to 2-1/8 inches, stretch measure. A detailed description of trawling gear designed especially for the industrial bottomfish fishery is given by Bullis, Captiva, and Knake (1960).

Before the first drag or tow with the main gear begins, a small 10-foot-wide trawl called the "try" net is towed from a stern davit to locate profitable concentrations of fish, preferably Atlantic croaker. During actual fishing operations, the "try" net is fished with the larger trawl to determine periodically the species composition and to estimate the quantity of fish being caught by the main gear. Generally, the main trawl is towed at a speed of 2 to 4 knots for 1 to 3 hours. The fleet fishes both day and night, with the largest catches reportedly being made during darkness.

To fulfill the needs of petfood and fish meal processors, some shrimp fishermen retain the industrial bottomfish they catch and, especially in periods of low brown shrimp abundance, seek fish during the day and shrimp at night.

CATCH-PROCESSING METHODS

General

Unloading the vessel is accomplished by flooding the hold and pumping out the water and the fish. The fish are delivered to a conveyor belt where undesirable species and debris, such as catfish, skates, crabs, shells, etc., are removed together with fish and shellfish of edible size which are sold separately.

Canning

Whole fish are automatically weighed as they move to the holding tanks filled with brine. Next they are conveyed to the extruder where a cutting worm minces the fish, after which it is blended with assorted grain cereals, soybean meal, and vitamin supplements. The fish are then precooked, or preheated by steam before being packed into cans. The cans are filled with petfood, sealed, and deposited in metal baskets which are placed in large retorts. The cans are cooked according to predetermined temperatures and lengths of time, both of which depend on the net weight and initial temperature of the canned product. Pressure is applied to ensure adequate sterilization within a reasonable length of time. The cans are removed and cooled with water before labeling, and are subsequently packed in cases for shipment to national wholesale and retail outlets. During 1959-63, the ex-vessel price varied little from $35 a ton.

In 1962 Mississippi led all states in the processing of bottomfish for canned petfood, accounting for 40 percent of the total U.S. pack of such products. This production was worth $14.9 million to Mississippi petfood processors (U.S. Fish and Wildlife Service, 1963). In the same year the total U.S. pack of pet food from fishery resources was more than twice the salmon packs, and approximately one-half the total pack of tuna for human consumption.

Reduction to Fish Meal

Fish and shellfish are unloaded as described for canning and conveyed immediately without culling to a pressurized steam cooker equipped with feed screw. After cooking, the material is passed through a rotary dryer, and then ground by a hammer mill. No oil or solubles are extracted in the process. Some petfood processors supply fish meal producers with the culled material resulting from their operations. Reduction plants pay $20 a ton for fish reduced into meal.

Fish meal, a valuable source of protein, is used by the poultry industry as a supplement in feed rations. It is usually mixed with dried materials such as alfalfa meal, bran, or other vegetables. Meal produced from Gulf bottomfish is now marketed in the Midwest.

Freezing

Preferred species for mink food include members of the Sciaenidae, or drum family, particularly the croaker, spot, sand seatrout, silver seatrout, and southern kingfish. After being washed and inspected, the fish are quick-frozen in 50-pound, open-top, tray-type fish boxes. Smaller sized boxes are frozen for use as crab bait. After freezing, the fish are held in cold storage and then shipped to mink ranches in the Midwest. Edible fish, crabs, and shrimp are marketed separately. Petfood processors can most of the culled fish. The price to the fisherman for fish destined for mink food and crab bait varies from $25 to $30 a ton.

HARVESTING THE RESOURCES

Historically, the small bottom dwelling fish of the Gulf of Mexico have been unutilized because of the absence of a market, but in recent years these fishes have achieved considerable importance as the principal raw material of the canned petfood industry. Several important features make small bottomfish desirable to the fishing interests. Fish occur in schools, and individuals are fairly uniform in size. These characteristics facilitate mass production methods of catching, handling, and processing. Most of the species undertake only limited seasonal migrations and tend to remain relatively close to shore where they are accessible to fishermen throughout the year.

FISHING GROUNDS

The shallow waters of the north-central Gulf of Mexico have recently been among the most productive fishing grounds in the world, both in tonnage caught and variety of species of fish and shellfish present in the catch. Menhaden, shrimp, oysters, crabs, and bottomfish are caught on the continental shelf and in the estuaries of Louisiana, Mississippi, and Alabama where bottom dwelling and floating organisms furnish an adequate food supply for the commercial species. The fertility of this relatively narrow and well-defined region is probably associated with nutrient salts and organic material contained in the heavy runoff from an area having the highest average annual rainfall in the eastern U.S., and in the large outflow of the Mississippi River.

Three commercial fisheries of major importance depend on the marine resources common to this area. The menhaden fishery, which harvests with purse seines large quantities of this herring-like fish (principally in estuaries and on the inner shelf), is by far the most important in tonnage landed. During 1959-63, annual recorded landings of menhaden from Louisiana and Mississippi waters averaged more than 400,000 tons. The fishery for shrimp is prosecuted in the estuaries and on the inner- and mid-shelf. During 1959-63, the annual commercial yield of shrimp from the Louisiana and Pensacola-Mississippi River coastal grounds averaged more than 37,000 tons, whole weight. Industrial bottomfish are commercially caught on the inner- and mid-continental shelf along 250 nautical miles of coastline near the Mississippi River Delta. The grounds extend seaward from shore to about 30 fathoms and vary in width from 3 miles off South Pass, La., to 50 miles south of Dauphin Island, Ala. The bottom area includes about 5,500 square nautical miles. It consists largely of mud and sand and is relatively level, providing excellent trawling conditions. The average annual landing of bottomfish during 1959-63 exceeded 41,000 tons.

The north-central Gulf was divided into the areas east and west of the Mississippi River Delta. This boundary passes through an area where the continental shelf is very narrow and relatively little or no fishing is done. Each area was then divided on the basis of seasonal fishing effort into two depth zones, one extending from 0 to 7 fathoms and the other from 7 to 30 fathoms. The four resulting subareas are defined as follows:

West Delta-nearshore.--Includes grounds west of South Pass at the Mississippi River Delta extending to a line running due south of Point au Fer, La. (lat. 29° 20' N. and long. 91° 29' W.), and from shore to 7 fathoms.

West Delta-offshore.--Includes grounds west of South Pass to a line running due south of Point au Fer, and located in 7 to 30 fathoms.

East Delta-nearshore.--Includes grounds east of South Pass to a line running due south of the entrance to Perdido Bay, Fla. (lat. 30° 16' N. and long. 87° 33' W.), and from shore to 7 fathoms.

East Delta-offshore.--Includes grounds east of South Pass to a line running due south of Perdido Bay entrance, and in 7 to 30 fathoms.

SPECIES TAKEN

The inner- and midshelf waters of the northern Gulf of Mexico are inhabited by many species of fish. Gunter (1945) identified 53 families and 119 species in an ecological study of the coastal fishes of Texas. Hildebrand (1954) sampled the bottom fauna in 12 to 24 fathoms between Ship Shoal and Southwest Pass, La., during June. Five 3-hour tows yielded bottomfish representing 30 families, which included 48 species. Sixty-seven families of fishes including at least 177 species have been identified in the commercial bottomfish landings off Louisiana, Mississippi, Alabama, and northwestern Florida. All species identified in the catch are listed in the Appendix. Four species of Sciaenidae contribute significantly to the overall tonnage--the croaker, spot, sand seatrout, and silver seatrout, which are classified as resident benthic species. Less important species are the sea catfish, longspine porgy, and cutlassfish or silvereel.

PRODUCTION

During the past 12 years the harvesting of industrial bottomfish by trawls has increased greatly. The petfood industry's need for fish first stimulated the bottomfish fishery. By 1954 two canneries in Mississippi processed more than 12,000 tons of fish (figure 2) and contributed measurably to a record pack of petfood in the United States. The Mississippi petfood industry continued to expand with the addition of two plants and increased its production to nearly 26,000 tons in 1957. Canning of bottomfish for petfood expanded rapidly in 1958 and was primarily responsible for the 60-percent increase in total bottomfish production. The remainder of the fish was reduced to meal for poultry food or was frozen for mink food and crab bait. Total harvest decreased slightly in 1960-61, but increased again in 1962 to a record catch of 48,000 tons with an estimated landed value of $1.6 million. A substantial decline occurred in 1963 when total production did not exceed 40,000 tons. Increased use of tuna, chicken, beef, and pork byproducts in canned petfoods was primarily responsible for a decrease in fish demand. Of the total catch processed during the 5 years, 83 percent was canned as petfood, while the remainder was frozen for mink food and crab bait, and reduced into fish meal for poultry feed.

FISHING EFFORT AND LANDINGS, 1959-63

Source of Data and Methods of Compilation

Analyses of fishing effort were based on the number of tows and average duration of tow obtained from interviews with fishermen and from logbooks issued to vessel captains. Records maintained by processing plants also were used, particularly information on the total number of landings (trips) and amount of fish landed. The number of trips from which fishing effort information was obtained represented about 20 percent of the total landings made by all trawlers in the industrial bottomfish fishery during the 5 years. Landings for reduction to fish meal at Apalachicola, Fla., in 1959 and 1960 were excluded from this study because effort data were not collected.

As already noted, the width of trawls used in the fishery varied appreciably. It was, therefore, desirable in calculating total effort to employ a standard-size trawl. The net most commonly used during the study period, and hence the one considered to have been the "standard" trawl, had a mouth width of 65 feet. Effort reported for vessels using larger or smaller nets was subsequently converted to standard-net units through its multiplication by the ratio of net width involved to that of the standard net.

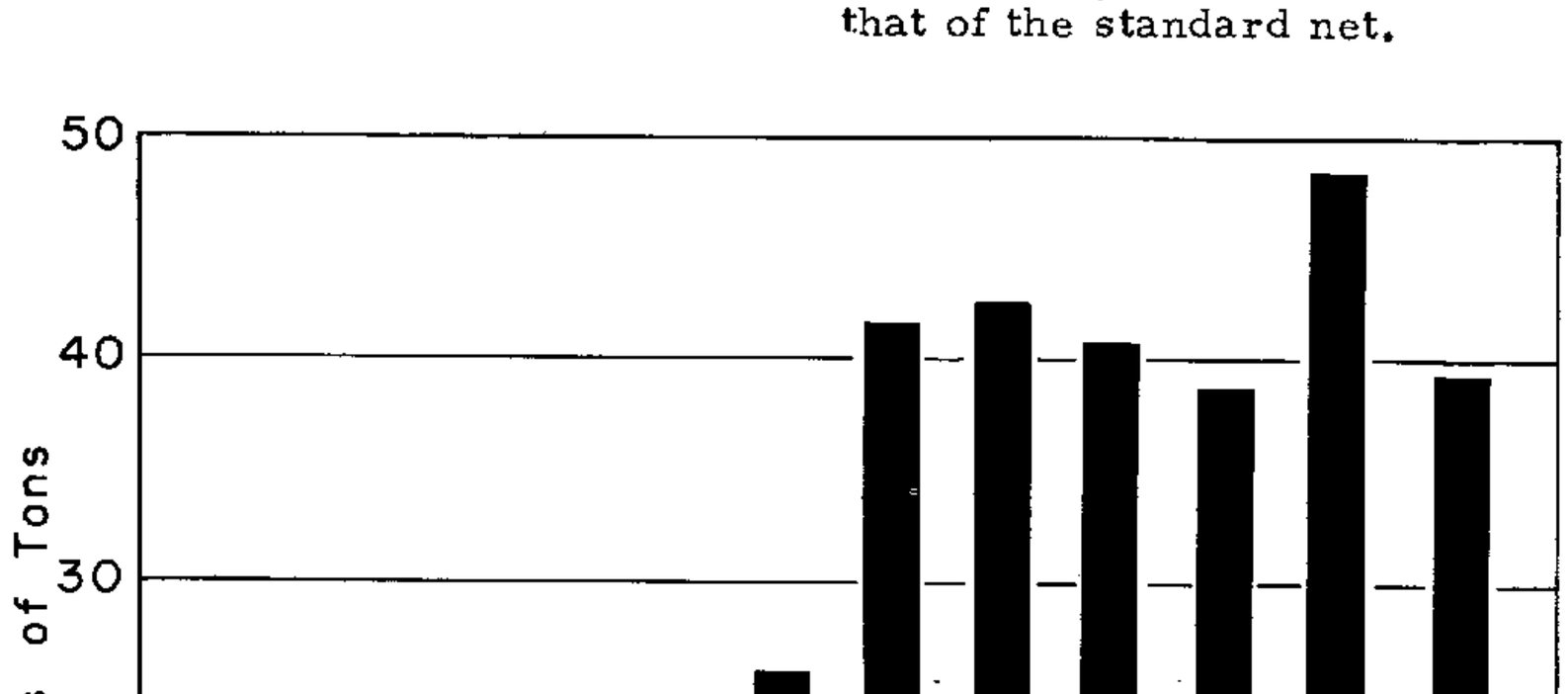

Figure 2.--Annual production by the industrial bottomfish fishery in the north-central Gulf of Mexico, 1952-63.

In summarizing the data for each month, the number of hours fished was tabulated by subsubareas that measured 10 minutes of latitude and 10 minutes of longitude.

The monthly subsubarea totals were summed on the basis of the geographical subarea previously described. Since coverage for effort within the north-central Gulf was incomplete, the estimated total number of hours fished by all vessels every month in each subarea (E) was calculated from information obtained through canvasses by the formula:

$$E = N\bar{x}$$

where N = total number of trips by all vessels in the subarea; and $\bar{x}$ = average number of "standard" hours fished per trip in the subarea by all canvassed vessels.

Effort statistics used in this study were calculated on the premise that all trawlers were equally efficient; i.e., all vessels had a simple linear relation between traveling time and corresponding catch.

Size and Distribution of Catch and Effort

Annual landings varied only slightly from an average of 39,500 tons during 1959-61 (figure 3, table 1). Landings in 1962 rapidly increased to a record of more than 48,000 tons but returned to the average level in 1963. During 1959-63, annual fishing effort on the grounds fluctuated markedly between 63,000 hours in 1960 and about 106,000 hours in 1962 (figure 3, table 2).

Annual landings from grounds west of the Mississippi River Delta declined by more than one-half from 1959 to 1961. This drop was due to a significant reduction in effort on both nearshore and offshore grounds. It is apparent, however, that the sharp rise in total landings for 1962 was the result of increased effort on both fishing grounds. Catch and effort continued at a high level on the same grounds in 1963. The average effort for the 5 years was 23,500 hours, with a maximum deviation of 69 percent. The average annual catch for the same period was 11,000 tons.

East of the Delta, annual landings remained comparatively stable from 1959 through 1962, averaging 31,600 tons, but declined to about 25,000 tons in 1963. A severe reduction in the effort expended offshore was apparently responsible for the decreased catch. Effort expended annually in nearshore and offshore areas (combined) averaged 57,000 hours, or 71 percent of the total, with a maximum deviation from the 5-year mean of 32 percent. Seventy-three percent of the total catch for the 5 years was made east of the Delta.

Separation of catch and effort data into monthly units of time showed definite patterns of annual and seasonal change within each fishing area (figure 4, tables 3 and 4).

West Delta-offshore--Annual bottomfish production ranged from about 10,000 tons (1959) to nearly 3,000 tons (1961) indicating a downward trend during the 3-year period. A threefold increase in production in 1962 was apparently due to a measurable upswing in effort.

It is evident that, seasonally, maximum production usually occurred early in the year between January and April, whereas minimum production occurred during June through August.

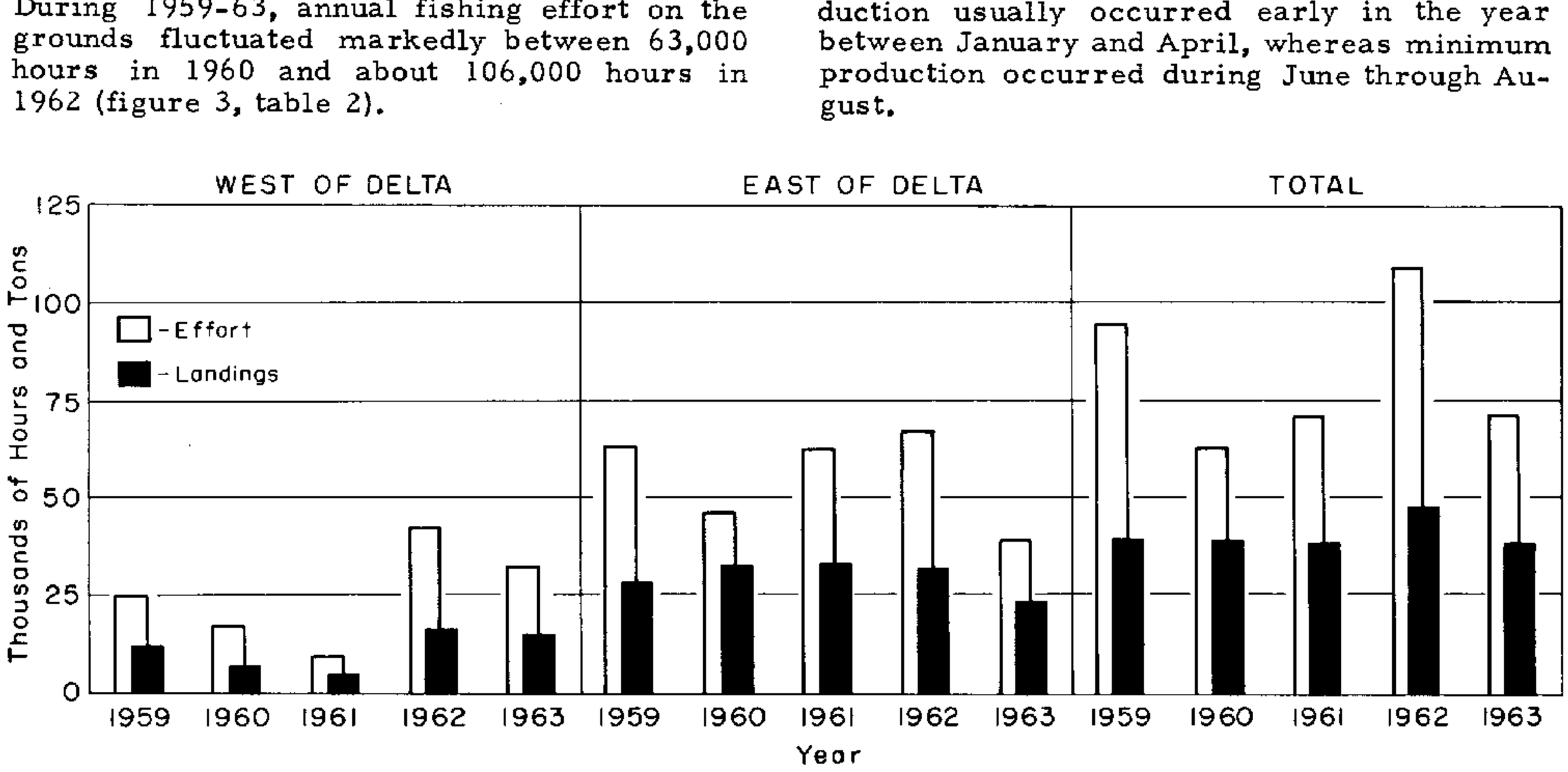

Figure 3.--Effort expenditure and total commercial landings by industrial bottomfish trawlers operating in the north-central Gulf of Mexico, 1959-63.

East Delta-offshore--Production increased sharply from 9,400 tons in 1959 to 14,600 tons in 1960, and remained relatively stable through 1962. The catch declined to a low of

Table 1.--Industrial bottomfish landings from the north-central Gulf of Mexico, 1959-63

Fishing area	Year					Composition of 5-year total
	1959	1960	1961	1962	1963	
	Tons	Tons	Tons	Tons	Tons	Percent
West of Delta:						
Nearshore.....	2,068	1,683	2,254	7,716	6,532	10
Offshore.....	9,886	5,867	2,776	7,976	8,256	17
Total.....	11,954	7,550	5,030	15,692	14,788	27
East of Delta:						
Nearshore.....	18,524	18,074	19,913	18,996	18,073	45
Offshore.....	9,404	14,606	13,486	13,552	6,714	28
Total.....	27,928	32,680	33,399	32,548	24,787	73
Total Gulf:						
Nearshore.....	20,592	19,757	22,167	26,712	24,605	55
Offshore.....	19,290	20,473	16,262	21,528	14,970	45
Total.....	39,882	40,230	38,429	48,240	39,575	100

Table 2.--Fishing effort expended by industrial bottomfish trawlers in the north-central Gulf of Mexico, 1959-63

Fishing area	Year					Composition of 5-year total
	1959	1960	1961	1962	1963	
	Hours	Hours	Hours	Hours	Hours	Percent
West of Delta:						
Nearshore.....	6,538	1,981	3,145	13,314	12,358	9
Offshore.....	19,130	14,676	4,329	22,120	19,806	20
Total.....	25,668	16,657	7,474	35,434	32,164	29
East of Delta:						
Nearshore.....	34,761	22,140	33,827	34,114	26,087	38
Offshore.....	30,528	24,178	31,002	36,121	12,895	33
Total.....	65,289	46,318	64,829	70,235	38,982	71
Total Gulf:						
Nearshore.....	41,299	24,121	36,972	47,428	38,445	47
Offshore.....	49,658	38,854	35,331	58,241	32,701	53
Total.....	90,957	62,975	72,303	105,669	71,146	100

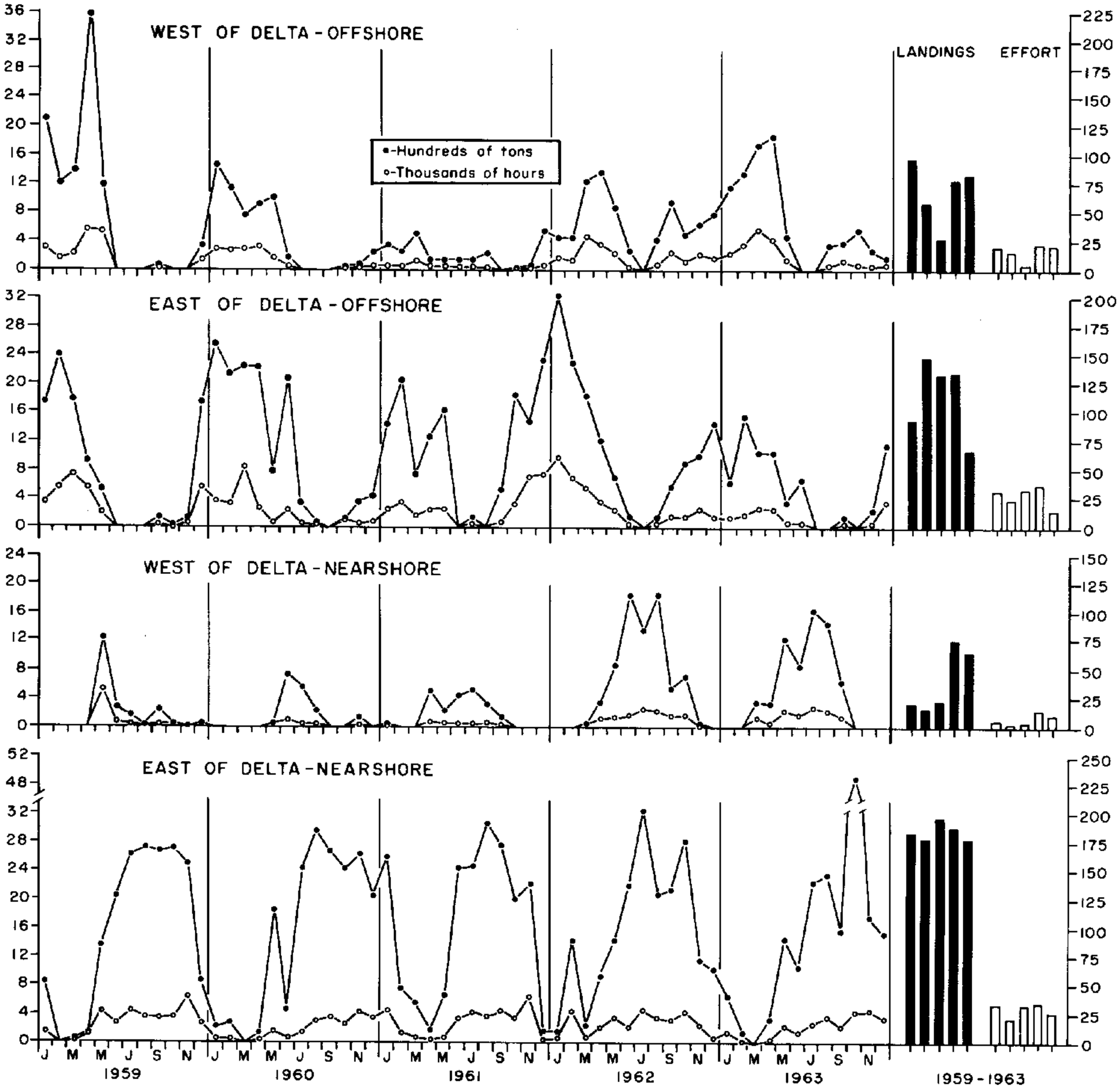

Figure 4.--Effort expenditure and commercial bottomfish landings by month, year, and subarea in the north-central Gulf of Mexico, 1959-63.

Table 3.--Industrial bottomfish landings by trawlers operating in the north-central Gulf of Mexico, 1959-63

Year and area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1959	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
West of Delta:													
Nearshore.....	--	--	--	--	1,240	276	154	27	223	48	21	79	2,068
Offshore.....	2,109	1,214	1,390	3,571	1,196	--	--	--	71	--	--	335	9,886
1960													
Nearshore.....	--	--	--	--	26	714	579	259	--	--	105	--	1,683
Offshore.....	1,479	1,121	789	915	1,001	191	--	--	--	36	81	254	5,867
1961													
Nearshore.....	25	--	--	508	255	472	530	319	145	--	--	--	2,254
Offshore.....	367	285	526	178	182	175	186	231	--	20	88	538	2,776
1962													
Nearshore.....	--	--	47	352	896	1,865	1,382	1,857	575	703	39	--	7,716
Offshore.....	440	441	1,258	1,398	875	257	--	410	942	497	658	800	7,976
1963													
Nearshore.....	--	--	344	319	1,252	877	1,631	1,487	622	--	--	--	6,532
Offshore.....	1,155	1,350	1,742	1,879	475	--	--	326	381	528	268	152	8,256
1959													
East of Delta:													
Nearshore.....	820	--	42	148	1,385	2,026	2,611	2,704	2,685	2,717	2,504	882	18,524
Offshore.....	1,775	2,390	1,798	910	512	--	--	--	112	41	132	1,734	9,404
1960													
Nearshore.....	208	283	--	114	1,852	478	2,408	2,971	2,698	2,420	2,624	2,018	18,074
Offshore.....	2,562	2,138	2,260	2,254	794	2,133	328	98	--	1,225	371	443	14,606
1961													
Nearshore.....	2,593	761	552	189	664	2,443	2,483	3,037	2,791	2,003	2,232	165	19,913
Offshore.....	1,472	2,058	744	1,286	1,624	--	114	--	512	1,849	1,488	2,339	13,486
1962													
Nearshore.....	144	1,469	263	943	1,424	2,204	3,245	2,092	2,184	2,815	1,184	1,029	18,996
Offshore.....	3,288	2,297	1,856	1,205	679	151	--	143	581	899	1,009	1,444	13,552
1963													
Nearshore.....	660	135	--	325	1,484	1,020	2,255	2,388	1,589	4,922	1,773	1,522	18,073
Offshore.....	609	1,552	1,046	1,029	326	652	--	--	120	--	208	1,172	6,714

6,700 tons in 1963, which corresponded with a marked reduction in effort.

Each year, landings reached a peak during January or February and were followed seasonally by little or no production between June and August. These seasonal variations correspond with those observed for the offshore grounds west of the Delta.

West Delta-nearshore--Averaging 2,000 tons, 1959-61 annual production was relatively stable. An increase in 1962 to almost 8,000 tons was apparently the result of a fivefold increase in fishing effort. Each year, the total catch and effort nearshore were consistently less than offshore.

East Delta-nearshore--Production remained almost the same each year with a maximum of about 20,000 tons being landed in 1961. The total annual catch of bottomfish from nearshore waters was greater than that from deeper waters offshore.

Seasonal variations in yields were similar to those on the nearshore grounds west of the Delta, with each year's peak production occurring somewhat later between July and October.

Geographical Distribution of Effort

The total number of hours spent trawling during 1959-63 was plotted by month on the basis of sub-subareas delineated by 10 minutes of latitude and 10 minutes of longitude. Because the effort data reflected seasonal changes in fishing intensity, monthly values were combined as follows: December through May (winter and spring) and June through November (summer and fall).

In general, fishing in winter and spring (figure 5) was conducted from shore to depths of 20 to 30 fathoms between Point au Fer and Southwest Pass, La., and from Pass a Loutre, La., to the vicinity of Perdido Bay

Table 4.--Effort expended by the commercial bottomfish fleet operating in the north-central Gulf of Mexico, 1959-63

Year and Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1959	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours	Hours
West of Delta:													
Nearshore.....	--	--	--	--	5,092	714	155	32	202	65	13	265	6,538
Offshore.....	2,982	1,656	2,203	5,649	5,175	--	--	--	90	--	--	1,375	19,130
1960													
Nearshore.....	--	--	--	--	44	978	425	390	--	--	144	--	1,981
Offshore.....	2,992	2,912	2,990	3,112	1,781	316	--	--	--	70	105	398	14,676
1961													
Nearshore.....	48	--	--	932	310	541	360	754	200	--	--	--	3,145
Offshore.....	620	385	1,120	312	270	346	129	194	--	52	136	765	4,329
1962													
Nearshore.....	--	--	170	1,097	1,381	1,776	2,716	2,325	1,765	1,980	104	--	13,314
Offshore.....	1,722	1,286	4,961	3,622	2,268	220	--	954	2,294	1,036	2,082	1,675	22,120
1963													
Nearshore.....	--	--	1,117	860	2,065	1,916	2,937	2,142	1,321	--	--	--	12,358
Offshore.....	2,259	3,067	5,420	4,137	1,277	--	--	534	1,191	839	570	512	19,806
1959													
East of Delta:													
Nearshore.....	1,411	--	204	1,107	4,224	2,856	4,386	3,791	3,641	3,951	6,386	2,804	34,761
Offshore.....	3,264	5,860	7,352	5,525	1,964	--	--	--	160	48	747	5,608	30,528
1960													
Nearshore.....	448	325	--	132	1,675	697	1,512	3,197	3,702	2,680	4,168	3,604	22,140
Offshore.....	3,861	3,681	8,169	2,512	714	2,185	202	190	--	1,116	623	925	24,178
1961													
Nearshore.....	4,523	1,190	962	335	923	2,875	4,294	4,057	4,472	3,354	6,288	554	33,827
Offshore.....	2,603	3,465	1,393	2,300	2,422	--	279	--	935	3,342	6,923	7,340	31,002
1962													
Nearshore.....	906	4,643	988	2,162	3,683	2,264	4,659	3,526	3,450	4,371	2,547	915	34,114
Offshore.....	9,807	6,990	5,691	3,605	2,399	486	--	304	1,304	1,593	2,559	1,383	36,121
1963													
Nearshore.....	1,171	126	--	404	2,212	1,420	2,700	3,738	2,184	4,382	4,510	3,240	26,087
Offshore.....	1,306	1,882	2,593	2,358	499	375	--	--	261	--	363	3,258	12,895

entrance, Fla. The area most heavily fished each year (more than 9 percent of the effort expended overall) was located in 7 to 12 fathoms off Horn Island, Miss. Areas where moderate effort (2.0 to 8.9 percent) was expended included the grounds at 5 to 12 fathoms east of Ship Shoal, La., at 7 to 18 fathoms off Chandeleur, Horn, Petit Bois, and Dauphin Islands, and at 5 to 15 fathoms in the Gulf east of the entrance to Mobile Bay, Ala. Sixty-four percent of the total effort was expended in the area east of the Delta during winter and spring.

The distribution of effort from summer through fall (figure 6) was generally the same as described for winter and spring. The nearshore grounds, however, were fished much more intensively in summer and fall. Heavy fishing near the entrance to Mobile Bay accounted for 35 percent of the total effort expended in the north-central Gulf during summer and fall. In the same period, 77 percent of the fishery's overall expenditure of effort occurred east of the Delta.

Composition of Landings

On the average, croaker, spot, and sand and silver seatrouts (combined) accounted for 75 percent of the annual industrial bottomfish landings from the north-central Gulf of Mexico during the 5 years (table 5). The croaker was by far the most important species harvested each year, averaging 56 percent of total catch weights while contributing tonnage of from 19,200 in 1960 to 28,600 in 1962; it was the principal species contributing to the marked increase in bottomfish landings in 1962. Cutlassfish, sea catfish, and longspine porgy followed in that order, contributing on the average 5, 2, and 2 percent by weight, respectively, to annual landings. At least 170 species were included in the "all others" category, with the more important representatives

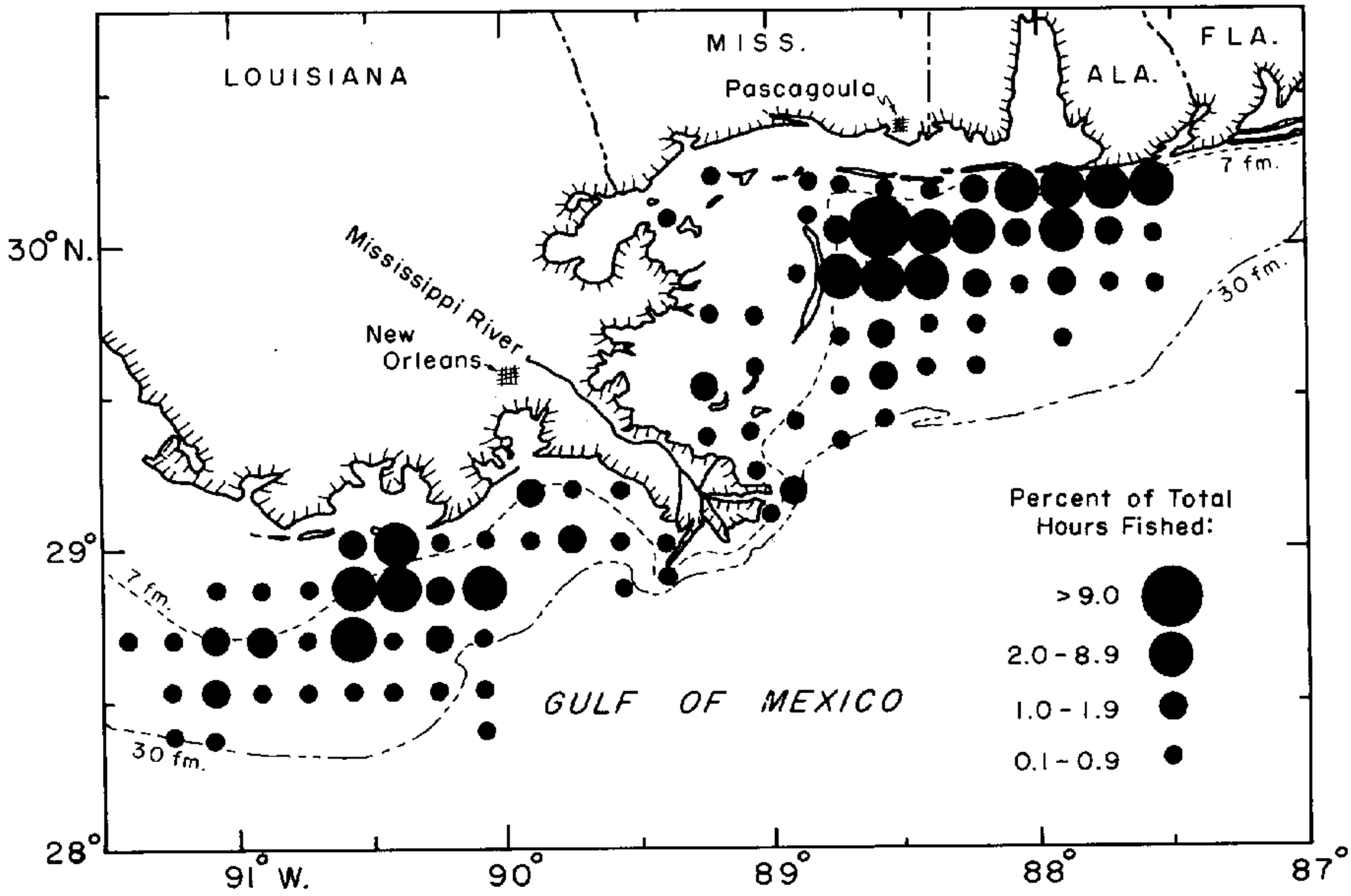

Figure 5.--Distribution of fishing effort in the industrial bottomfish fishery of the northern Gulf of Mexico during winter and spring, 1959-63.

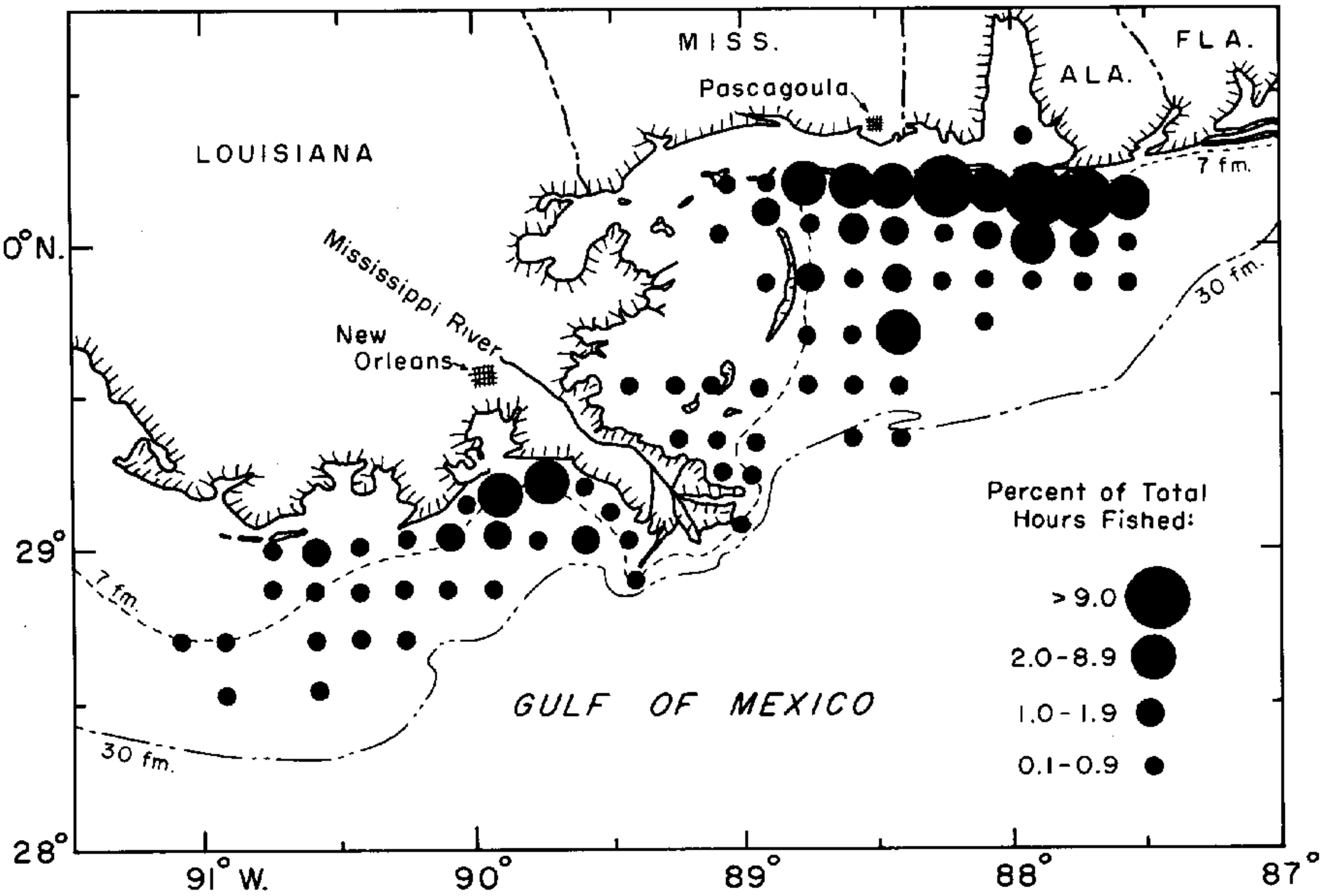

Figure 6.--Distribution of fishing effort in the industrial bottomfish fishery of the northern Gulf of Mexico during summer and fall, 1959-63.

Table 5.--Species composition of industrial bottomfish landings from the north-central Gulf of Mexico, 1959-63

Species	Year					Average	Composition of 5-year total
	1959	1960	1961	1962	1963		
	Tons	Tons	Tons	Tons	Tons	Tons	Percent
Croaker.....	20,108	19,185	22,077	28,628	24,814	22,962	56
Spot.....	5,409	4,565	4,547	4,741	3,772	4,607	11
Seatrout[1].....	3,927	4,041	1,946	3,945	2,456	3,263	8
Cutlassfish.....	1,201	1,969	2,658	2,477	1,635	1,988	5
Sea catfish.....	1,201	797	1,000	1,213	965	1,035	2
Longspine porgy.....	733	1,046	974	1,036	780	914	2
All others.....	7,303	8,627	5,227	6,200	5,153	6,502	16
Total.....	39,882	40,230	38,429	48,240	39,575	41,271	100

[1] Includes sand and silver seatrouts.

being the striped anchovy, bay anchovy, scaled sardine or razorbelly, butterfish, inshore lizardfish, and southern kingfish or groundmullet.

Croaker, spot, seatrouts, and cutlassfish were caught on each ground throughout most of the year (table 6). The croaker is the major species caught each month in all four fishing areas. The largest catches of spot were usually made nearshore and offshore east of the Delta, with maximum catches in December and January. Lesser amounts were caught in the West Delta area. Both species of seatrout prevailed in greater amounts nearshore, and offshore west of the Delta. Increased quantities entered nearshore catches from July through October, and offshore catches between January and April. Cutlassfish contributed to catches made nearshore west of the Delta during June, July, and August, and offshore from May through July. East of the Delta, significant amounts were present nearshore between May and October, and offshore during August and September. Relatively large amounts of longspine porgy were present offshore east of the Delta between February and May.

Annual catches of the more important species are listed by fishing grounds in table 7. Largest catches of croaker were made east of the Delta, and varied on the nearshore grounds from over 7,000 tons (1960) to almost 11,000 tons (1962). The absolute tonnage of croaker caught offshore ranged from about 4,000 (1963) to 8,000 (1960, 1961). Average croaker catches exceeded by 2-1/2 times those made west of the Delta. It is also evident that the marked increase previously noted for this species in 1962 was primarily the result of a 3-1/2-fold increase in the combined croaker catches from the nearshore and offshore grounds west of the Delta. Spot were also caught in larger quantities throughout the east Delta area during the 5 years, while both species of seatrout contributed substantially to annual catches made nearshore east and offshore west of the Delta. The largest catches of cutlassfish occurred each year in the nearshore waters east of the Delta with the maximum catch exceeding 2,000 tons (1961). Fishermen usually avoid capturing this species because it is difficult to handle and process. Larger amounts of cutlassfish are often available nearshore, particularly during the summer.

Table 6.--Contribution of major species to industrial bottomfish landings from the north-central Gulf of Mexico, 1959-63

Species and Area	Month												Average
	J	F	M	A	M	J	J	A	S	O	N	D	
Atlantic croaker	%	%	%	%	%	%	%	%	%	%	%	%	%
West Delta:													
Nearshore....	80	--	86	71	74	65	62	67	63	41	45	78	61
Offshore.....	56	60	55	58	50	63	59	70	59	70	59	69	61
East Delta:													
Nearshore....	56	66	53	64	76	48	45	47	57	48	61	56	56
Offshore.....	56	67	60	48	36	66	37	47	66	69	57	57	55
Spot													
West Delta:													
Nearshore....	7	--	(*)	3	4	3	4	3	4	26	1	--	5
Offshore.....	7	7	6	9	5	4	2	6	6	4	7	2	5
East Delta:													
Nearshore....	27	7	9	9	19	15	16	12	10	10	4	18	13
Offshore.....	20	14	10	15	16	12	17	11	4	6	15	21	13
Sand and silver seatrouts													
West Delta:													
Nearshore....	6	--	(*)	6	5	9	13	10	14	15	31	9	10
Offshore.....	23	18	21	15	10	10	5	6	11	6	12	12	12
East Delta:													
Nearshore....	2	2	8	1	5	6	5	8	8	11	7	2	5
Offshore.....	3	2	3	9	5	1	3	11	7	8	7	6	5
Cutlassfish													
West Delta:													
Nearshore....	(*)	--	3	5	4	10	12	10	5	2	2	1	4
Offshore.....	(*)	(*)	2	2	15	11	24	5	10	3	5	(*)	6
East Delta:													
Nearshore....	(*)	2	2	2	22	8	9	10	7	8	1	(*)	6
Offshore.....	(*)	(*)	(*)	2	3	3	5	16	8	5	(*)	(*)	3
Sea catfish													
West Delta:													
Nearshore....	(*)	--	1	4	5	2	3	3	4	2	4	--	2
Offshore.....	3	3	2	1	1	3	--	3	2	5	6	5	3
East Delta:													
Nearshore....	(*)	3	3	4	11	4	3	4	4	2	2	(*)	3
Offshore.....	2	(*)	2	1	3	(*)	4	(*)	4	(*)	(*)	1	1
Longspine porgy													
West Delta:													
Nearshore....	(*)	--	(*)	(*)	--	(*)	--	--	--	(*)	1	--	(*)
Offshore.....	(*)	1	1	1	1	--	--	(*)	--	(*)	(*)	(*)	(*)
East Delta:													
Nearshore....	(*)	2	4	(*)	(*)	(*)	(*)	(*)	(*)	2	3	(*)	(*)
Offshore.....	2	6	9	10	11	2	2	(*)	(*)	1	4	2	4

*Less than 1 percent.

Table 7.--Species composition of industrial bottomfish landings, by subarea, from the north-central Gulf of Mexico, 1959-63

Species	Year					Average	Composition of 5-year total
	1959	1960	1961	1962	1963		
West Delta: Nearshore:	Tons	Tons	Tons	Tons	Tons	Tons	Percent
Croaker	1,370	917	1,428	5,230	4,408	2,671	66
Spot	109	91	114	372	164	170	4
Seatrout[1]	173	250	213	597	737	394	10
Cutlassfish	118	145	182	498	689	326	8
Sea catfish	101	44	96	239	171	130	3
Longspine porgy	1	2	1	6	---	2	1
All others	197	234	220	774	363	358	9
Total	2,068	1,683	2,254	7,716	6,532	4,051	100
West Delta: Offshore:							
Croaker	4,400	3,216	1,750	4,887	5,971	4,045	58
Spot	846	396	172	485	309	442	6
Seatrout[1]	2,355	1,111	314	968	824	1,114	16
Cutlassfish	283	90	135	594	170	254	4
Sea catfish	272	124	104	235	174	182	3
Longspine porgy	90	102	29	70	47	68	1
All others	1,640	828	272	737	761	848	12
Total	9,886	5,867	2,776	7,976	8,256	6,952	100
East Delta: Nearshore:							
Croaker	8,936	7,048	10,744	10,975	10,214	9,583	51
Spot	2,805	2,189	2,300	1,725	2,310	2,266	12
Seatrout[1]	1,188	1,580	936	1,580	761	1,209	6
Cutlassfish	761	1,498	2,065	1,209	700	1,247	7
Sea catfish	693	481	629	459	530	558	3
Longspine porgy	79	320	202	294	282	235	1
All others	4,062	4,958	3,037	2,754	3,276	3,617	20
Total	18,524	18,074	19,913	18,996	18,073	18,716	100
East Delta: Offshore:							
Croaker	5,402	8,004	8,155	7,536	4,221	6,664	58
Spot	1,649	1,889	1,961	2,159	989	1,729	15
Seatrout[1]	211	1,100	483	800	134	546	5
Cutlassfish	39	236	276	176	76	161	1
Sea catfish	135	148	171	280	90	165	1
Longspine porgy	564	622	742	666	451	609	5
All others	1,404	2,607	1,698	1,935	753	1,679	15
Total	9,404	14,606	13,486	13,552	6,714	11,552	100

[1] Includes silver and sand seatrouts.

TRENDS IN POPULATION SIZE

The term population refers herein to that portion of a fishable stock present within the geographical boundaries of the four northern Gulf coast areas designated earlier and is not meant to imply the existence of distinguishable subpopulations.

The mean annual catch in weight per hour for all species combined was used as a measure, or index, of the annual population present in each fishing area. The fundamental assumption in its use is that the trawl takes, on the average, a constant proportion of the total fish of catchable size present on the grounds at the time of fishing, whether fish are

abundant or scarce. Abundance is defined as the absolute weight of fish accessible to the fishery, as affected by availability.

Several factors should be kept in mind when using catch per hour as an index of comparative bottomfish abundance. Because the index reflects is a constantly changing quantity its values are accurate only for a short time and a specific locality. Adequate catch and effort data that are well distributed in time and space must therefore be used. To eliminate bias due to insufficient data, I deleted the values for those months in which effort totalled less than 100 hours. The population estimate used in this study does not account for bottomfish caught by shrimp vessels operating each month of the year in the north-central Gulf. The annual discard of fish at sea during shrimping operations may amount to several thousand tons, but an accurate measure of its magnitude has never been obtained. As a consequence, the calculated statistics give an incomplete picture of total effort expenditure and harvest of bottomfish in the northern Gulf coast area and permit assessment of only those portions of the resource yielding to the commercial bottomfish fishery. The premise that all trawlers are equally efficient is questionable since studies have shown that larger trawlers with greater horsepower and speed tend to catch more fish per unit time than smaller vessels. These factors and limitations undoubtedly cause error and bias, and conceivably affect the accuracy of the abundance index. Nevertheless, such an estimator provides a rough measure of the broad changes in the bottomfish population.

The comparative approach is used in an attempt to make a quantitative analysis of the bottomfish population on northern Gulf fishing grounds. Monthly and annual indices are plotted to compare variations in population abundance within and between fishing areas. Analysis and interpretations of calculated trends seek to show the effect of fishing on population abundance. Conclusions are made as to whether the overall bottomfish resource has adequately maintained itself during the study period, and projections are made regarding future levels of harvest intensity.

West Delta.--Comparative interpretation of figure 7A is difficult because of limited data for both the nearshore and offshore grounds. Seasonal peaks, however, are distinguishable and show that large concentrations (an index of 1 or more tons per hour) of bottomfish were usually available nearshore in June and July. It is significant that moderate (1/2 - 1 ton) to large (over 1 ton) concentrations of fish are often present offshore between June and August when little or no fishing activity takes place. This situation apparently indicates that fishermen prefer to trawl in nearshore areas. Fishing operations nearshore and offshore seemed to be characterized by abrupt and marked fluctuations in catch per hour which occurred simultaneously in each area. Otherwise, abundance levels were generally similar on both grounds for the remaining months in which values are comparable.

East Delta.--Fluctuations of bottomfish abundance on the nearshore grounds east of the Delta generally coincided with those shown by curves derived from data of operations on the offshore grounds (figure 7B). Overall seasonal trends in abundance were nearly the same on both grounds, with most values at similar levels. In most instances where data were available, bottomfish abundance on the offshore grounds was moderate to great from June through August, the same condition as was noted for the West Delta area.

Population data for nearshore and offshore stocks showed appreciable similarity on West

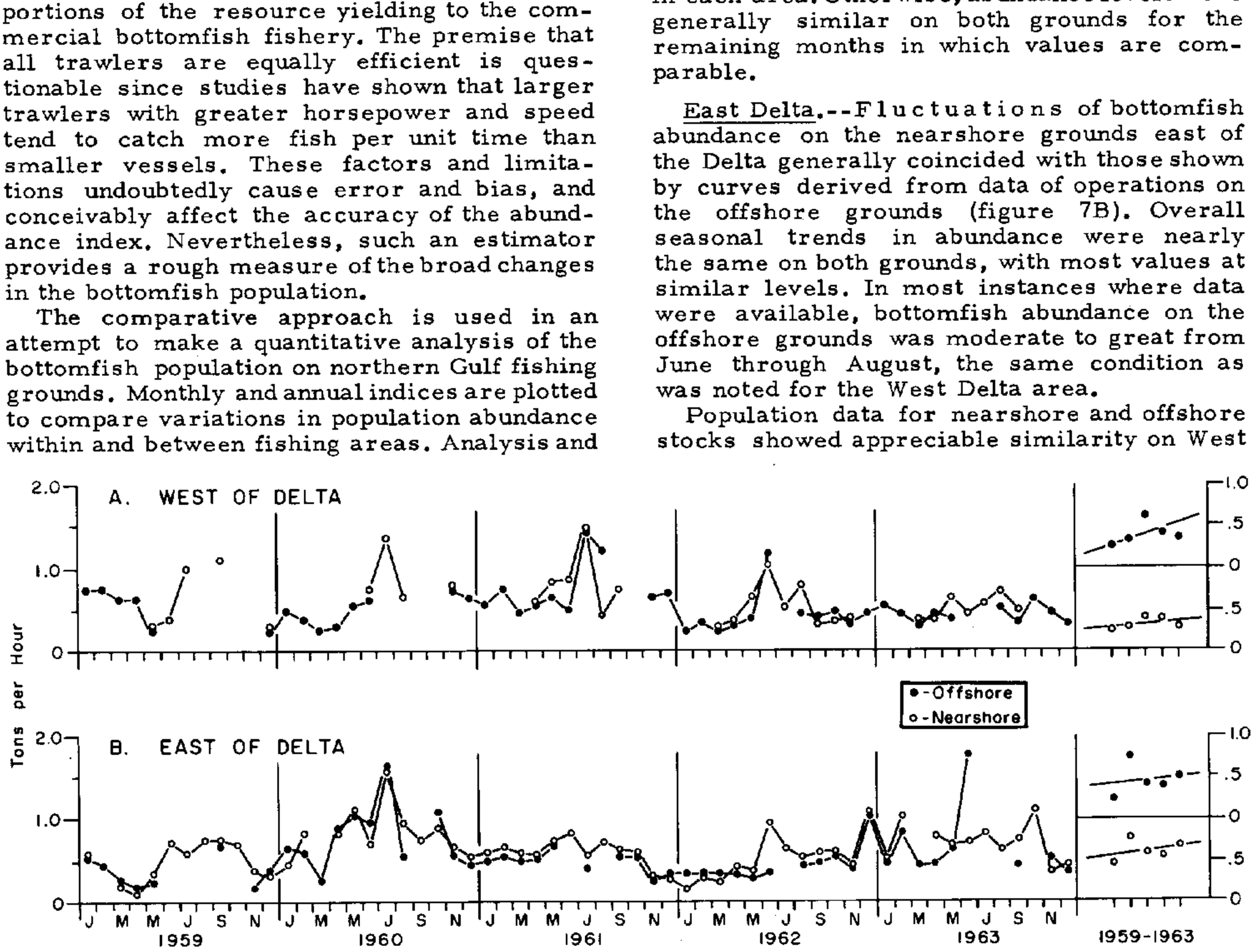

Figure 7.--Average catch of bottomfish per hour of trawling along the north-central coast of the Gulf of Mexico, 1959-63.

and East Delta grounds. Seasonal trends generally corresponded and annual fluctuations paralleled one another quite closely. The overall trends for the 5 years were also comparable and indicated a slight rise in each of the four subareas. The data therefore suggest that the bottomfish present nearshore and offshore were contingents of the same population unit and that the factors governing abundance on one ground operate similarly on the other ground as well.

To determine how the commercial bottomfish populations reacted to fishing, an analysis was made of effort and catch statistics as well as of mean annual abundance indices (figure 8). Nearshore and offshore data were combined and trends calculated. Upward trends in commercial landings from both the West and East Delta areas were associated with rising trends in fishing effort. Trends in overall level of population size, as indicated by the mean annual catch-per-hour values, were also

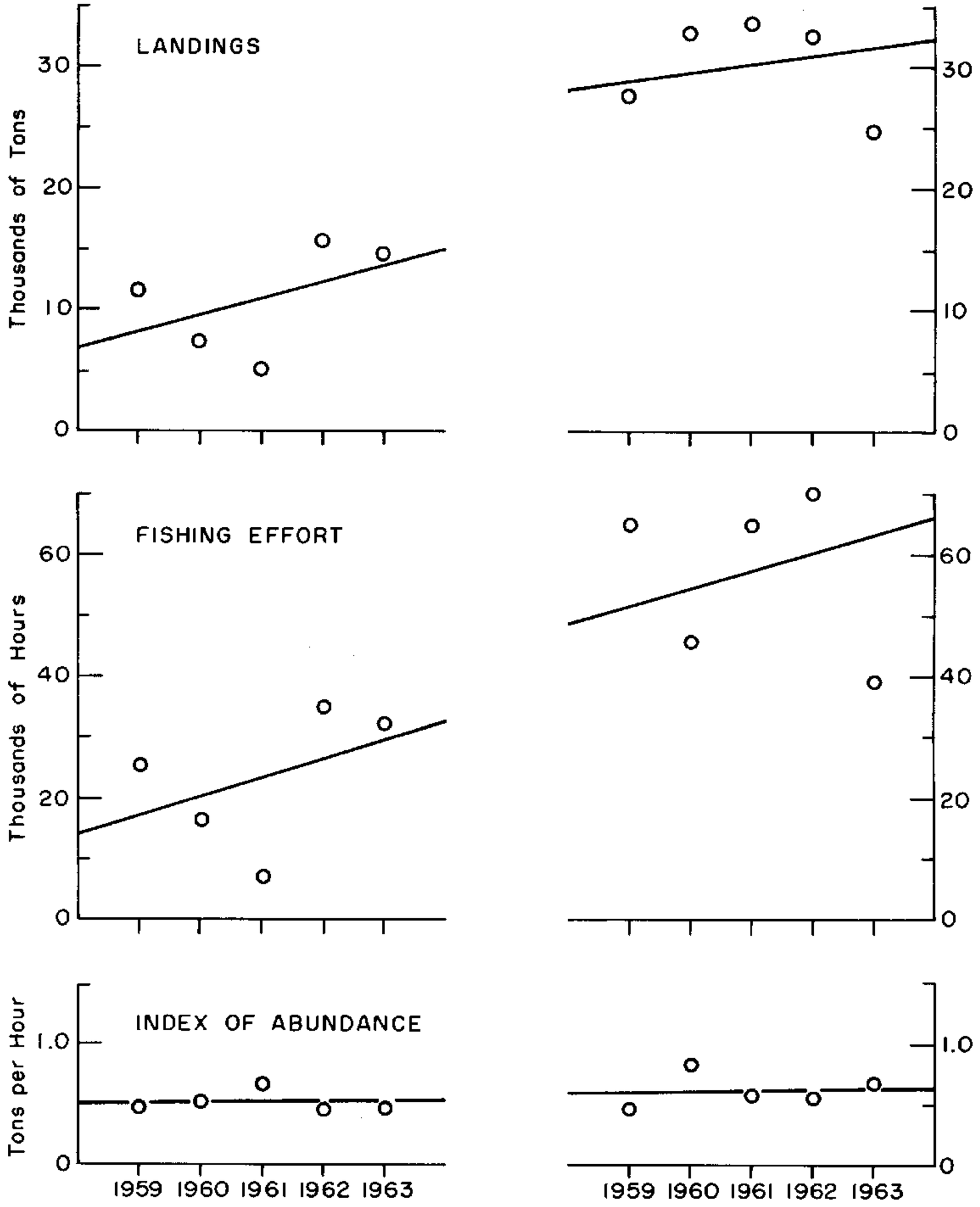

Figure 8.--Relations between available bottomfish population, landings, and fishing effort in the north-central Gulf of Mexico, 1959-63.

perceptibly upward, suggesting that the bottomfish resource adequately maintained itself during the 5 years of fishing being reviewed here.

That the total stock was not subjected to excessive fishing is also indicated by above-average yields of croaker during 1961-63 from nearshore grounds east of the Delta, where intensive effort was expended each year.

To determine optimum fishing grounds for the industrial bottomfish fishery of the north-central Gulf, I compared average annual fish abundance for the years 1959-63 and its variability from year to year. This method is similar to one developed by Klages (1942) who delineated optimum geographical regions for the production of certain agricultural crops. The area with the highest average (annual) abundance and the lowest coefficient of variation represents the ground where, over the years, average fishing success was consistently greatest.

By this means of assessment, the nearshore area east of the Mississippi River Delta (summer-fall) proved to be the most productive bottomfish ground (table 8). Although year-to-year fish abundance on the nearshore grounds west of the Delta (summer-fall) was identical, its annual variation was greater (17 percent). Fish abundance on the nearshore grounds east of the Delta during winter and spring was relatively high (0.54 tons per hour), but its annual variation was the greatest of all four areas. Each season the offshore grounds east and west of the Delta harbored smaller concentrations of bottomfish than the nearshore grounds. Annual variation in offshore stock abundance was intermediate between comparable measures for nearshore grounds east and west of the Delta.

Table 8.--Average annual abundance and variability of industrial bottomfish populations in the north-central Gulf of Mexico, 1959-63

Area	Average annual abundance	Coefficient of variation
	Tons per hour	Percent
Nearshore (winter-spring):		
East of Delta.....	0.54	28.8
West of Delta[1].....	--	--
Nearshore (summer-fall):		
East of Delta.....	.69	13.8
West of Delta.....	.69	16.7
Offshore (winter-spring):		
East of Delta.....	.46	26.5
West of Delta.....	.45	21.0
Offshore (summer-fall):		
East of Delta.....	.46	25.5
West of Delta.....	.46	28.6

[1] Insufficient data.

RECOMMENDATIONS

As previously mentioned, the total catch of bottomfish in the commercial shrimp fishery within northern Gulf coast waters is unknown. Quantitative analyses of commercial shrimp catches from the grounds in the 5- to 10-fathom depth range off St. Augustine, Fla., have shown, however, that for every pound of shrimp caught (whole weight) about 8-1/4 pounds of bottomfish were taken (Wolff, 1963). A similar ratio was reported by Miles (1951) in an analysis of fish caught by shrimp trawlers operating in Apalachicola Bay and the adjoining Gulf of Mexico. In 1959, the catch of commercial shrimp at 0-20 fathoms in the Pensacola-Mississippi River coastal area was 6,500 tons, whole weight (Kutkuhn, 1962). If the catch ratio of shrimp to fish is set at 1:8, then the estimated catch of bottomfish by shrimp trawlers totaled about 52,000 tons, or nearly twice the amount landed by industrial fish trawlers operating east of the Delta in 1959. It is noteworthy that the catch of menhaden recorded for Mississippi in 1959 was about 87,000 tons.

Accordingly, the following suggestions are offered to develop the potential of the bottomfish resource in the Gulf of Mexico:

1. Because bottomfish caught during commercial shrimping operations have the greatest potential as raw material for the fish meal industry throughout most of the year, they should be retained and processed.

2. More of the bottomfish concentrations should be harvested on the offshore grounds in 7 to 30 fathoms east and west of the Mississippi River Delta between June and August.

3. Bottomfish stocks should be fished during the winter when reduction plants and most shrimp vessels must otherwise remain idle.

SUMMARY

The trawl fishery for industrial bottomfish in the northern Gulf of Mexico has expanded rapidly since 1952. Statistics reveal that from 1959 through 1963, the north-central Gulf of Mexico annually produced between 38,000 and 48,000 tons of bottomfish for animal food markets. Annual expenditures of effort over the 5 years ranged between 63,000 and 106,000 hours of trawling. About 73 percent of the total production was taken from the area lying between the Mississippi River Delta and the approach to Mobile Bay. Catches in waters of 7 fathoms or less represented about 55 percent of the Gulf total. Although overall landings varied only moderately during the 5 years, production fluctuated sharply at certain seasons and in certain areas. Statistics showed that the increased effort and catches made

west of the Delta were responsible for record production in 1962.

Of the four major species supporting the Gulf of Mexico bottomfish fishery, the Atlantic croaker was the most important and, on the average, contributed 56 percent of the annual production. Lesser quantities of spot, sand seatrout, and silver seatrout were present in catches throughout every year of the survey. Cutlassfish entered catches seasonally from May through October on the shallow-water grounds, whereas the longspine porgy occurred on the deeper grounds between October and May. At one season or another and in varying degree, a total of at least 177 species may be expected to contribute to northern Gulf bottomfish landings.

The fishery's more important trawling grounds were situated nearshore between the entrance to Mobile Bay and the Mississippi River Delta. The trawler fleet generally operated throughout the north-central Gulf from shore to 7 fathoms between June and November, and in 7 to 30 fathoms from December through May. The optimum bottomfish ground (summer-fall) was located inside the 8-fathom curve east of the Mississippi River Delta.

Increased fishing effort was responsible for increased yields west and east of the Mississippi River Delta during 1959-63, while bottomfish population levels remained relatively stable.

Recommendations are concerned with fuller utilization of the bottomfish resource available to fishermen on the established grounds.

ACKNOWLEDGMENTS

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LITERATURE CITED

BULLIS, H. R., F. J. CAPTIVA, and B. O. KNAKE.
1960. Trawling gear designed for industrial fish production. Fish Boat Ybk. 5(3): 18-21, 91-92.

GUNTER, G.
1945. Studies on marine fishes of Texas. Univ. Tex. Publ. Inst. Mar. Sci. 1(2): 1-190.

HILDEBRAND, H. H.
1954. A study of the fauna of the brown shrimp (Penaeus aztecus Ives) grounds in the western Gulf of Mexico. Univ. Tex. Publ. Inst. Mar. Sci. 3(2): 1-366.

KLAGES, K. H. W.
1942. Ecological crop geography. Macmillan Co., New York, 615 p.

KUTKUHN, JOSEPH H.
1962. Gulf of Mexico commercial shrimp populations--trends and characteristics, 1956-59. U.S. Fish Wildl. Serv., Fish. Bull. 62: 343-402.

MILES, R. M.
1951. An analysis of the "trash fish" of shrimp trawlers operating in Apalachicola Bay and the adjacent Gulf of Mexico. Unpublished Thesis, Fla. St. Univ., Tallahassee, Fla., 1-46.

THOMPSON, J. R., and W. A. HASKELL.
1960. From trash to treasure. Petfood Ind. 2(12): 10-13.

U.S. FISH and WILDLIFE SERVICE.
1963. Canned fishery products--1962 annual summary. Comm. Fish. Statist. 3144: 1-17.

WOLFF, R. P.
1963. The potential use of trash fish caught by shrimp trawlers. Univ. Miami. Small Business Study, Inst. Mar. Sci.: 1-34.

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APPENDIX

Table A-1.--List of fishes entering industrial bottomfish catches in the north-central Gulf of Mexico

Family	Scientific name	Common name
Carcharhinidae.....	Carcharhinus limbatus.....	Blacktip shark.
	Mustelus canis.....	Smooth dogfish.
	Mustelus norrisi.....	Florida smoothhound.
	Rhizoprionodon terraenovae.....	Atlantic sharpnose shark.
	Galeocerdo cuvieri.....	Tiger shark.
Sphyrnidae.....	Sphyrna tiburo.....	Bonnethead.
	Sphyrna zygaena.....	Smooth hammerhead.
	Sphyrna mokarran.....	Great hammerhead.
Squatinidae.....	Squatina dumerili.....	Atlantic angel shark.
Pristidae.....	Pristis pectinatus.....	Smalltooth sawfish.
Rhinobatidae.....	Rhinobatos lentiginosus.....	Atlantic guitarfish.
Torpedinidae.....	Narcine brasiliensis.....	Lesser electric ray.
Rajidae.....	Raja texana.....	Roundel skate.
	Raja eglanteria.....	Clearnose skate.
Dasyatidae.....	Dasyatis americana.....	Southern stingray.
	Dasyatis sayi.....	Bluntnose stingray.
	Gymnura micrura.....	Smooth butterfly ray.
Myliobatidae.....	Aetobatus narinari.....	Spotted eagle ray.
	Rhinoptera bonasus.....	Cownose ray.
Acipenseridae.....	Acipenser oxyrhynchus.....	Atlantic sturgeon.
Elopidae.....	Elops saurus.....	Ladyfish.
	Megalops atlantica.....	Tarpon.
Clupeidae.....	Alosa alabamae.....	Alabama shad.
	Alosa chrysochloris.....	Skipjack herring.
	Brevoortia gunteri.....	Finescale menhaden.
	Brevoortia patronus.....	Largescale menhaden.
	Brevoortia smithi.....	Yellowfin shad.
	Dorosoma cepedianum.....	Gizzard shad.
	Dorosoma petenense.....	Threadfin shad.
	Etrumeus teres.....	Atlantic round herring.
	Harengula pensacolae.....	Scaled sardine.
	Opisthonema oglinum.....	Atlantic thread herring.
	Sardinella anchovia.....	Spanish sardine.
Engraulidae.....	Anchoviella perfasciata.....	Flat anchovy.
	Anchoa hepsetus.....	Striped anchovy.
	Anchoa mitchilli.....	Bay anchovy.
Synodidae.....	Synodus foetens.....	Inshore lizardfish.
	Synodus intermedius.....	Sand diver.
	Trachinocephalus myops.....	Snakefish.
Ariidae.....	Bagre marinus.....	Gafftopsail catfish.
	Galeichthys felis.....	Sea catfish.

Table A-1.--List of fishes entering industrial bottomfish catches in the north-central Gulf of Mexico--Continued

Family	Scientific name	Common name
Anguillidae.....	Anguilla rostrata.....	American eel.
Muraenidae.....	Gymnothorax nigromarginatus.....	Blackedge moray.
Congridae.....	Congrina flava.....	Yellow conger.
	Ariosoma impressa.....	Bandtooth conger.
	Hoplunnis macrurus.....	Silver conger.
Ophichthidae.....	Letharchus velifer.....	Sailfin eel.
	Mystriophis intertinctus.....	Spotted spoon-nose eel.
	Ophichthus gomesi.....	Shrimp eel.
	Ophichthus ocellatus.....	Palespotted eel.
Belonidae.....	Tylosurus acus.....	Needlefish.
Hemiramphidae.....	Hyporhamphus unifasciatus.....	Halfbeak.
Gadidae.....	Urophycis floridanus.....	Southern hake.
	Urophycis regius.....	Spotted hake.
Macrouridae.....	Steindachneria argentea.....	Grenadier.
Fistulariidae.....	Fistularia tabacaria.....	Cornetfish.
Syngnathidae.....	Syngnathus scovelli.....	Gulf pipefish.
	Hippocampus erectus.....	Spotted seahorse.
Serranidae.....	Centropristis ocyurus.....	Bank sea bass.
	Centropristis philadelphicus.....	Rock sea bass.
	Diplectrum formosum.....	Sand perch.
	Epinephelus nigritus.....	Warsaw grouper.
	Mycteroperca microlepis.....	Gag.
	Mycteroperca phenax.....	Scamp.
	Rypticus saponaceus.....	Soapfish.
	Serraniculus pumilio.....	Pygmy sea bass.
Lobotidae.....	Lobotes surinamensis.....	Tripletail.
Lutjanidae.....	Lutjanus blackfordi.....	Red snapper.
	Lutjanus griseus.....	Gray snapper.
	Lutjanus synagris.....	Lane snapper.
	Ocyurus chrysurus.....	Yellowtail snapper.
	Pristipomoides andersoni.....	Wenchman.
	Rhomboplites aurorubens.....	Vermilion snapper.
Priacanthidae.....	Priacanthus arenatus.....	Bigeye.
	Pseudopriacanthus altus.....	Short bigeye.
Pomatomidae.....	Pomatomus saltatrix.....	Bluefish.
Rachycentridae.....	Rachycentron canadum.....	Cobia.

Table A-1.--List of fishes entering industrial bottomfish catches in the north-central Gulf of Mexico--Continued

Family	Scientific name	Common name
Carangidae	Alectis crinitus	African pompano.
	Caranx crysos	Blue runner.
	Caranx hippos	Crevalle jack.
	Decapterus punctatus	Round scad.
	Chloroscombrus chrysurus	Bumper.
	Oligoplites saurus	Leatherjacket.
	Selar crumenophthalmus	Bigeye scad.
	Selene vomer	Lookdown.
	Seriola dumerili	Greater amberjack.
	Seriola zonata	Branded rudderfish.
	Hemicaranx amblyrhynchus	Bluntnose jack.
	Trachinotus carolinus	Pompano.
	Vomer setapinnis	Atlantic moonfish.
Gerridae	Eucinostomus gula	Silver jenny.
Pomadasyidae	Orthopristis chrysopterus	Pigfish.
	Haemulon aurolineatum	Tomtate.
	Conodon nobilis	Barred grunt.
Sciaenidae	Bairdiella chrysura	Silver perch.
	Cynoscion arenarius	Sand seatrout.
	Cynoscion nebulosus	Spotted seatrout.
	Cynoscion nothus	Silver seatrout.
	Pareques acuminatus	Cubbyu.
	Equetus lanceolatus	Jackknife-fish.
	Larimus fasciatus	Banded drum.
	Leiostomus xanthurus	Spot.
	Menticirrhus americanus	Southern kingfish.
	Menticirrhus focaliger	Minkfish.
	Micropogon undulatus	Atlantic croaker.
	Pogonias cromis	Black drum.
	Sciaenops ocellata	Red drum.
	Stellifer lanceolatus	Star drum
Mullidae	Mullus auratus	Red goatfish.
	Pseudupeneus maculatus	Spotted goatfish.
Sparidae	Archosargus probatocephalus	Sheepshead.
	Lagodon rhomboides	Pinfish.
	Stenotomus caprinus	Longspine porgy.
	Pagrus sedecim	Red porgy.
Ephippidae	Chaetodipterus faber	Atlantic spadefish.
Chaetodontidae	Chaetodon ocellatus	Spotfin butterflyfish.
	Holacanthus ciliaris	Queen angelfish.
Labridae	Halichoeres caudalis	Painted wrasse.
	Xyrichthys psittacus	Pearly razorfish.
Trichiuridae	Trichiurus lepturus	Atlantic cutlassfish.
Scombridae	Scomberomorus cavalla	King mackerel.
	Scomberomorus maculatus	Spanish mackerel.
	Scomber colias	Chub mackerel.
Gobiidae	Gobioides broussonneti	Violet goby.
	Gobionellus hastatus	Sharptail goby.

Table A-1.--List of fishes entering industrial bottomfish catches in the north-central Gulf of Mexico--Continued

Family	Scientific name	Common name
Scorpaenidae	Scorpaena brasiliensis	Barbfish.
	Scorpaena calcarata	Smoothhead scorpionfish.
	Scorpaena plumieri	Spotted scorpionfish.
Peristediidae	Peristedion gracile	Armored searobin.
Triglidae	Prionotus tribulus	Bighead searobin.
	Bellator militaris	Horned searobin.
	Prionotus rubio	Blackfin searobin.
Uranoscopidae	Astroscopus y-graecum	Southern stargazer.
Blenniidae	Hypsoblennius hentzi	Feather blenny.
Brotulidae	Brotula barbata	Bearded brotula.
Ophidiidae	Ophidion welshi	Crested cusk-eel.
	Ophidion holbrooki	Bank cusk-eel.
	Rissola marginata	Striped cusk-eel.
Stromateidae	Peprilus paru	Northern harvestfish.
	Poronotus burti	Butterfish.
Sphyraenidae	Sphyraena guachancho	Guaguanche.
Mugilidae	Mugil curema	White mullet.
Atherinidae	Membras martinica	Rough silverside.
Polynemidae	Polydactylus octonemus	Atlantic threadfin.
Bothidae	Ancylopsetta quadrocellata	Ocellated flounder.
	Citharichthys macrops	Spotted whiff.
	Cyclopsetta chittendeni	Mexican flounder.
	Etropus crossotus	Fringed flounder.
	Paralichthys albigutta	Gulf flounder.
	Paralichthys lethostigma	Southern flounder.
	Syacium gunteri	Shoal flounder.
	Syacium papillosum	Dusky flounder.
Soleidae	Achirus lineatus	Lined sole.
	Gymnachirus texae	Naked sole.
	Trinectes maculatus	Hogchoker.
Cynoglossidae	Symphurus civitatus	Offshore tonguefish.
	Symphurus plagiusa	Blackcheek tonguefish.
Echeneidae	Echeneis naucrates	Sharksucker.
Balistidae	Balistes capriscus	Scrawled filefish.
Monacanthidae	Alutera scripta	Orange filefish.
	Alutera schoepfi	Gray triggerfish.
	Stephanolepis hispidus	Planehead filefish.
Ostraciidae	Lactophrys quadricornis	Cowfish.

Table A-1.--List of fishes entering industrial bottomfish catches in the north-central Gulf of Mexico--Continued

Family	Scientific name	Common name
Tetraodontidae.....	Lagocephalus laevigatus.....	Smooth puffer.
	Sphaeroides nephelus.....	Southern puffer.
	Sphaeroides spengleri.....	Bandtail puffer.
Diodontidae.....	Chilomycterus schoepfi.....	Striped burrfish.
Batrachoididae.....	Porichthys porosissimus.....	Atlantic midshipman.
	Opsanus beta.....	Gulf toadfish.
Antennariidae.....	Antennarius nuttingi.....	Dusky frogfish.
	Antennarius radiosus.....	Singlespot frogfish.
	Antennarius scaber.....	Splitlure frogfish.
	Histrio histrio.....	Sargassumfish.
Ogcocephalidae.....	Halieutichthys aculeatus.....	Spiny batfish.
	Ogcocephalus nasutus.....	Shortnose batfish.
	Ogcocephalus radiatus.....	Polka-dot batfish.
	Ogcocephalus vespertilio.....	Longnose batfish.

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